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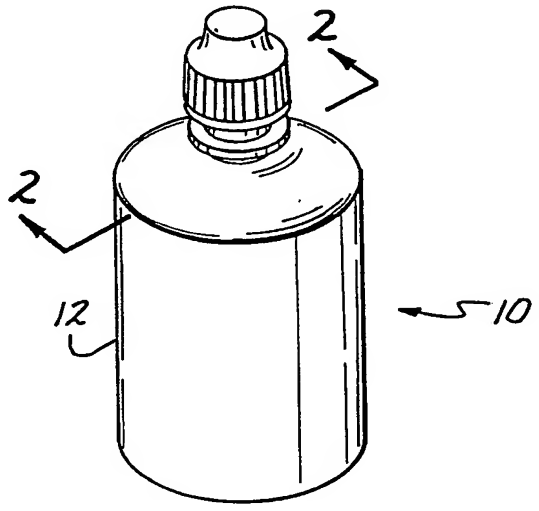

(57) Abstract

An apparatus for dispensing an useful product, for example, liquid medium containing chlorine dioxide, comprises a first container section which defines a receptacle (12) adapted for holding a first component, for example, precursor liquid medium having chlorine dioxide precursor therein, and including an outlet (14) through which the useful product exits the first container section; a second container section adapted to carry, or to define a space in which is contained at least a portion of, a second component (20), for example a promoter component effective to promote the generation of chlorine dioxide from the chlorine dioxide precursor in the liquid medium present in the receptacle; and an isolation assembly (16, 18) which when inactivated acts to effectively keep the second component out of contact with the first component in the receptacle. When the isolation assembly is activated, it acts to facilitate the contacting of the second component and the first component in the receptacle.

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USEFUL PRODUCT DELIVERY APPARATUS

BACKGROUND OF THE INVENTION

This invention relates to an apparatus for the delivery of an useful product, for example, liquid medium containing chlorine dioxide. More particularly, the invention relates to an apparatus for the delivery of an useful product derived from the interaction of a first component and a second component, for example, liquid medium containing chlorine dioxide derived by activating a liquid medium containing chlorine dioxide precursor with a metal component.

In general, many situations exist where useful products are subject to deterioration, for example, if they are prepared well in advance of being used. Long periods of time for transportation and/or storage before delivery to the ultimate consumer may result in a product which is ineffective for its intended use. In these instances, it would be highly advantageous to make the final useful product at a time reasonably close to the time the product is to be used.

To illustrate, the use of chlorine dioxide dissolved in an aqueous liquid medium to disinfect substrates, such as contact lenses, has previously been suggested. However, the stability/solubility of chlorine dioxide in water is quite low so that active chlorine dioxide cannot be maintained in aqueous solution for long periods of time. One approach to providing a liquid medium containing chlorine dioxide is to use a liquid medium containing a chlorine dioxide precursor, such as stabilized chlorine dioxide, and to subject this liquid medium to the action of a transition metal component present in the same container with the contact lens to be disinfected. The transition metal component activates or promotes the chlorine dioxide precursor to generate chlorine dioxide

which disinfects the contact lens. One difficulty that exists with this approach is that one or more contaminants, for example, tear proteins, associated with a contact lens to be disinfected may cause the transition metal component to become ineffective over time to promote the generation of chlorine dioxide.

Therefore, it would be advantageous to generate chlorine dioxide from a chlorine dioxide precursor relatively close to the time the chlorine dioxide is to be used without exposing the metal component to an environment containing the substrate, for example, the contact lens, to be disinfected.

SUMMARY OF THE INVENTION

A new apparatus for delivering or dispensing an useful product, for example, liquid medium containing chlorine dioxide, has been discovered. The present apparatus provides for the generation of the final useful product in the delivery apparatus by the controlled interaction of two components. The final useful product is fresh or active and ready for use when needed.

Although the present apparatus has particular applicability to delivering chlorine dioxide-containing liquid medium, embodiments of the present apparatus are effective to deliver any useful product which is derived from the interaction of two components where it is desired or advantageous to keep the two components separated until the appropriate component-component interaction is desired. The first and second components may be in any form or forms, e.g., liquid, solid and/or gas. The interaction may be of any type, for example, physical combining, physical mixing, chemical reacting, promoted, e.g., catalytic, interacting and the like. The second component when contacted with the first component

interacts with the first component and generates or promotes the generation of the useful product, which is then available for delivery by the present apparatus.

Although the present system is described hereinafter with particular emphasis on the delivery of liquid medium containing chlorine dioxide, it is to be understood that the present invention has a more general applicability. Thus, embodiments directed to this more general applicability are within the scope of the present invention.

With regard to the delivery of useful chlorine dioxide-containing liquid medium product, the present apparatus provides for activation of chlorine dioxide precursor (a first component) in a liquid medium, preferably an aqueous liquid medium, to generate a liquid medium containing chlorine dioxide, preferably a disinfecting amount of chlorine dioxide (an useful product). This apparatus generates the liquid medium containing chlorine dioxide by the interaction of the chlorine dioxide precursor with a promoter component (a second component) separate and apart from the substrate, for example, a contact lens, to be disinfected. Thus, the apparatus is unaffected by the substrate and has no substantial effect on the substrate. In addition, the apparatus effectively prevents premature generation of chlorine dioxide-containing liquid medium. In this manner, the chlorine dioxide precursor-containing liquid medium is effectively prevented from forming chlorine dioxide until desired. For example, such chlorine dioxide formation is prevented during pre-use shipment and storage of the chlorine dioxide precursor-containing product. This "chlorine dioxide generation prevention" feature of the present invention reduces, or even substantially

eliminates, the risk that the chlorine dioxide precursor will prematurely decompose to chlorine dioxide and, overall, facilitates the effective use of such precursor.

In one broad aspect of the present invention, an apparatus for delivering a liquid medium containing chlorine dioxide (an useful product) comprises a first container section, a second container section, a promoter component (a second component) and an isolation means. The first container section defines a receptacle for holding a precursor liquid medium having chlorine dioxide precursor (a first component) located therein and includes an outlet conduit through which liquid medium containing chlorine dioxide exits the receptacle. The second container section is adapted to carry, or define a space in which is contained at least a portion of, the promoter component. The promoter component is effective to promote the generation of chlorine dioxide from the chlorine dioxide precursor present in the precursor liquid medium in the receptacle. The present isolation means when inactivated acts to effectively keep the promoter component out of contact with the precursor liquid medium in the receptacle. The isolation means is capable of being activated, as desired, to act to facilitate the contacting of the promotor component and the precursor liquid medium in the receptacle.

Using the present apparatus, a liquid medium containing a disinfecting amount of chlorine dioxide can be generated and passed to a container where disinfection occurs, such as a lens container where contact lens disinfection occurs. Prior to use, for example, during pre-use shipment and storage, the precursor liquid medium in the receptacle is effectively separated or isolated from the promoter component so that little or no premature

or unwanted generation of chlorine dioxide is obtained. Thus, the precursor liquid medium in the receptacle is maintained in a ready or unaltered state until it is desired to generate chlorine dioxide, for example, for disinfection purposes.

Methods for dispensing or delivering a liquid medium containing chlorine dioxide (an useful product), preferably containing dissolved chlorine dioxide, derived from the controlled interaction of a liquid medium containing chlorine dioxide precursor (a first component) and a promoter component (a second component), preferably utilizing apparatus as disclosed herein, are within the scope of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

The present invention involves an apparatus useful for delivering a liquid medium containing chlorine dioxide (an useful product), preferably a contact lens disinfecting amount of chlorine dioxide.

The present apparatus includes a first container section which defines a receptacle adapted for holding a precursor liquid medium having chlorine dioxide precursor therein (a first component). The first container section also includes an outlet conduit through which liquid medium, in particular chlorine dioxide-containing liquid medium, exits the receptacle. A second container section is provided and acts to carry, or to define a space in which is contained at least a portion of, a promoter component (a second component). The present promoter component, preferably comprising a metal component, is effective when contacted with the precursor liquid medium in the receptacle to promote the generation of chlorine dioxide from the chlorine dioxide precursor in the precursor liquid medium in the receptacle. The isolation

means of the present system, when inactivated, acts to effectively keep the promoter component out of contact with the precursor liquid medium in the receptacle. When the isolation means is activated, it facilitates the contacting of the promoter component and the precursor liquid medium in the receptacle.

In one embodiment, the promoter component is located in the second container section when the isolation means is inactivated. After the isolation means is activated, the promoter component is located in the receptacle. Preferably, the isolation means is capable of being activated in response to manual force being applied to the isolation means. The second container section preferably defines an outlet through which liquid exits the system. The second container section is movable relative to the first container section to activate the isolation means. The apparatus preferably further includes a removable block member located in relation to the first and second container sections so as to prevent movement of the second container section relative to the first container section to activate the isolation means. This block member should be removed before activating the isolation means. The present apparatus may be structured to limit the movement of the second container section relative to the first container section in at least one direction.

In one embodiment, the second container section is at least partially located within the first container section and the first container section includes a first threaded surface. The apparatus further comprises a removable cap including a second threaded surface. The threads of the first and second threaded surfaces are mutually engageable to hold the cap onto the first container section. The removable cap is preferably structured so that the

threading of the second threaded surface onto the first threaded surface acts to move the second container section relative to the first container section to activate the isolation means.

In order to avoid accidental activation of the isolation means, the first container section and isolation means may be structured to resist activation of the isolation means. In a particularly useful embodiment, the first container section includes a recess or a projection and the isolation means includes a correspondingly sized and configured projection or recess. Thus, the first container section and the isolation means are held together by a recess/projection combination to resist activation of the isolation means.

In a further embodiment, the present apparatus further comprises a plunger member adapted to come into contact with the first container section and to move the second container section relative to the first container section in response to an applied force to activate the isolation means. This applied force may be applied generally along the longitudinal axis of the second container section. The apparatus may include a removable cap adapted to cover the second container section during periods of non-use. This cap includes a cap body and the plunger member. The cap body may include a top rim and the plunger member is recessed relative to the top rim. Such configuration reduces the risk of accidentally or unintentionally applying a force to the plunger member to activate the isolation means.

The cap body and plunger member may be structured to resist the initial movement of the plunger member relative to the cap body. For example, the cap body may include a recess or a projection and the plunger member may include

a correspondingly sized and configured projection or recess. Thus, the cap body and plunger member together include a recess/projection combination which acts to resist the initial movement of the plunger member relative to the cap body. Such structure reduces the risk of unintentional activation of the isolation means. The cap body and plunger member are preferably structured to resist movement of the plunger member relative to the cap body after the isolation means is activated by movement of the plunger member.

In another useful embodiment, the second container section is structured to be moveable along its longitudinal axis in a direction generally away from the receptacle to activate the isolation means. The first container section and second container section may be structured to limit the movement of the second container section relative to the first container section along its longitudinal axis in the direction generally away from and/or toward the receptacle. The second container section may include a gripping recess adapted to facilitate the gripping of the second container section by a human user in moving the second container section, e.g., generally along its longitudinal axis, relative to the first container section.

A further embodiment of the present apparatus includes a nozzle element which extends into the outlet and into the second container section and provides a path through which liquid medium exits the apparatus. This nozzle element is moveable relative to the first container section to activate the isolation means. The nozzle element is preferably structured to extend outwardly from the second container section when the isolation means in inactivated. To activate the isolation means, the nozzle

element is moved inwardly toward the receptacle. The first container section and nozzle element may be structured to resist movement of the nozzle element relative to the first container section after activation of the isolation means. This feature provides that the nozzle element is in place in the outlet for use in dispensing the chlorine dioxide-containing liquid medium. In this embodiment, the second container section is preferably stationary relative to the first container section. The second container section may include a recess or a projection with the nozzle element including a correspondingly sized and configured projection or recess. In this manner the second container section and nozzle element are held together by a recess/projection combination to resist relative movement of the nozzle element and the first container section, and preferably the second container section, after activation of the isolation means.

In an additional embodiment of the present invention, the second container section is compressible, with one end portion thereof being substantially stationary relative to the first container section. The isolation means preferably includes a sealed barrier which is activated by being unsealed, for example, by compressing the second container section. More preferably, the sealed barrier is secured to the second container section, for example, at or near the above-noted substantially stationary end of the second container section. A particularly useful apparatus further includes a substantially rigid ramming member located within the second container section and acting to facilitate the activation of the isolation means, the unsealing of the sealed barrier, as the second container section is compressed.

In yet another embodiment of the present invention, the isolation means includes a barrier and a breaking element adapted to break the barrier to activate the isolation means. For example, the first container section may include a threaded surface and the second container section also includes a threaded surface. The threads of these two threaded surfaces are mutually engageable to threadably secure the second container section to the first container section. The promoter component is preferably carried by, more preferably secured to, the second container section. The barrier, which is preferably secured to and a part of the first container section, is broken as the second container section is threaded onto the first container section. Preferably, the second container section carries the breaking element. In this embodiment, the first container section, except for the barrier, is preferably substantially rigid.

In a still further embodiment, the isolation means includes a seal adapted to be broken to allow precursor liquid medium from the receptacle to contact the promoter component. In this embodiment, the receptacle is preferably flexible. The barrier may be adapted to be broken by applying hand pressure to the first container section. Alternatively, the apparatus may include a clip positioned to maintain the seal intact. The clip is removable to break the seal.

In another embodiment, the promoter component is secured to the second container section, which is preferably shipped while being wrapped separately from the first container section. The promoter component is adapted to extend into the receptacle, after the isolation means has been activated. The second container section preferably includes an outlet port through which liquid

medium can pass, from the receptacle out of the apparatus. A cover may be provided, for example, secured to the second container section, and is adapted to cover the outlet port during periods when chlorine dioxide-containing liquid is not being dispensed. The isolation means preferably includes a shipping cap adapted to be removably secured to the first container portion during shipment and before use of the apparatus. This shipping cap acts to retain the precursor liquid medium in the receptacle and out of contact with the promoter component during shipment and before use of the apparatus. The second container section is adapted to be shipped without the promoter component extending into the receptacle. When it is desired to activate this apparatus, the shipping cap is removed from the first container section, and the second container section is positioned so that the promoter component extends into the receptacle and the second container section is secured to the first container section.

In a further additional embodiment, the promoter component is adapted to be shipped secured, in particular removably secured, to the second container section and to be released into the receptacle in response to a releasing force, e.g., a force generated by a human hand, being applied to the second container section when the second container section is placed over the outlet conduit of the first container section. Releasing the promoter component into the receptacle in this manner effectively activates the apparatus. The second container section preferably includes a recess into which the promoter component is placed, for example, for shipment. This recess is preferably deformable so that the releasing force acts to deform the recess, thereby forcing the promoter component

out of the recess. In this embodiment, the isolation means includes a cap, which preferably includes an outlet port through which liquid medium can pass, from the receptacle out of the apparatus, and a cover adapted to cover the outlet port during periods of time when liquid medium in not being dispensed from the apparatus. This cap acts to retain the precursor liquid medium in the receptacle and out of contact with the promoter component during shipment. The first container section is shipped with precursor liquid medium in the receptacle and the cap covering the outlet conduit. The second container section is preferably wrapped separately from the first container section during shipment.

The apparatus is activated by removing the cap from the first container section and placing the second container section over the outlet conduit. A releasing force is applied to the second container section to cause the promoter component to pass into the receptacle. The second container section may then be removed from over the outlet conduit. A cap with an outlet port, and preferably a cover, as described above, is then secured to the first container section over this outlet conduit. At this point, the apparatus is ready to dispense chlorine dioxide-containing liquid medium.

Any metal component capable of promoting the generation or formation of chlorine dioxide from a chlorine dioxide precursor in a liquid medium, in particular in an aqueous liquid medium, preferably at a pH in the range of about 6 to about 10 or possibly higher, may be employed in the promoter component of the present invention. The preferred metal components include the transition metals and mixtures thereof, in particular selected from the metals of the following groups of the

Periodic Table of Elements: Group III metals, Group IV metals, Group V metals, Group VI metals, Group VII metals, Group VIII metals and mixtures thereof.

Because of their high degree of effectiveness, platinum group metal components and mixtures thereof, preferably platinum components, palladium components, ruthenium components and mixtures thereof, and especially palladium components and mixtures thereof, are particularly useful. The platinum group metals include platinum, palladium, iridium, ruthenium, rhodium and osmium.

The metal component or components may be present in the metallic form and/or in a combined form as part of an organic or inorganic compound or complex.

The amount of metal components or components needed in the present promoter component is to be viewed in terms of what quantity is needed to generate a particular concentration of chlorine dioxide over a given time and in light of the amount of chlorine dioxide precursor present in the precursor liquid medium. An amount of metal component sufficient to provide the desired amount or concentration, preferably an effective disinfecting amount, of chlorine dioxide is included in the present system. However, care should be exercised to avoid the use of excessive amounts of metal components. The use of excessive amounts of metal component may be wasteful, costly (in view of the high cost of the preferred platinum group metals), and may result in the production of excessive amounts of chlorine dioxide, which can result in rapid and wasteful decomposition of the chlorine dioxide precursor in the receptacle.

It is most convenient to place the metal component on a support. Such supports are particularly useful if the

metal components include one or more platinum group metals, which are quite expensive. The support may be chosen so as to provide surface area on which the metal component or components can be placed.

Any suitable support material may be employed, and preferably is substantially inert at the conditions employed in the present invention. Examples of support materials include polymeric materials (plastics), metals, aluminas, silicas, clays, ceramics and the like. The supported transition metal component or components may have any suitable shape or configuration, such as sheets, films, rods, extrudates, tablets, pills, irregular shaped particulates, spheres, cylinders, disks and the like. The transition metal component may be in granular or powder form and supported on a larger particle or structure. Any of a number of conventional techniques can be employed to incorporate the metal component or components in and/or on the support material. These techniques include impregnation, co-precipitation, ion-exchange, dipping, spraying, vacuum deposition, vapor deposition and the like.

The chlorine dioxide-containing liquid medium dispensed or delivered by the present apparatus is applicable to disinfecting many substrates which are benefited by being disinfected, in particular all types of contact lenses. Such lenses may be made of any material or combination of materials and may have any suitable configuration. For example, these chlorine dioxide-containing liquid media can be used to disinfect lenses made from hydrogels ("soft" lenses), lenses made from polymethyl methacrylate (PMMA), the so called "hard" lenses and other non-hydrogel gas permeable lenses. Present day examples or non-hydrogel gas permeable lens

materials are organosiloxane-methacrylate polymers (Polycon® lenses), fluorocarbon polymers (Advent® lenses), cellulose acetate butyrate (CAB) materials and silicone elastomer of various compositions.

In general, such chlorine dioxide-containing liquid media contain sufficient chlorine dioxide to disinfect a given device in a given period of time. Preferably, such liquid media contain at least about 0.1 ppm, more preferably about 0.2 ppm, and still more preferably at least about 0.5 ppm, by weight of chlorine dioxide. Such amounts of chlorine dioxide, when present in solution in an aqueous liquid medium, disinfect the device, in particular the contact lens, contacting such aqueous liquid medium in about 1 to about 2 hours or less. Higher amounts of chlorine dioxide disinfect in a shorter period of time.

In general, the chlorine dioxide precursors referred to herein are compounds capable of generating, releasing or being converted to, chlorine dioxide when exposed to the promoter component, in particular to a metal component included in the promoter component. Among the preferred chlorine dioxide precursors useful in the present invention are chlorites and stabilized chlorine dioxide. The term "stabilized chlorine dioxide" as used herein includes, for example, one or more chlorine dioxide-containing complexes disclosed in U.S. Patents 4,696,811 and 4,689,215 each of which is incorporated in its entirety by reference herein. Chlorites include metal chlorite salts, particularly alkali metal chlorites. A specific example of a chlorite salt which is useful as a chlorine dioxide precursor is sodium chlorite. Among the preferred chlorine dioxide-containing complexes are carbonate and bicarbonate complexes. The exact chemical

composition of many of these chlorine dioxide precursors is not completely understood. The manufacture or production of certain chlorine dioxide precursors is described in McNicholas U.S. Patent 3,278,447, which is hereby incorporated in its entirety by reference herein. An especially useful stabilized chlorine dioxide is a product sold by Bio-Cide International, Inc. under the trademark Purogene®.

The chlorine dioxide precursor is preferably present in the precursor liquid medium at a predetermined concentration so as to provide a disinfecting amount of chlorine dioxide in the presence of the promoter component. Preferably, the precursor liquid medium has sufficient chlorine dioxide precursor so as to have a potential of producing a chlorine dioxide-containing liquid medium having a chlorine dioxide concentration of at least about 0.1 ppm by weight.

In one embodiment, the chlorine dioxide precursor includes a functionality selected from carbonate, borate, sulfate, phosphate, and mixtures thereof. Without intending to limit the scope of the present invention to any particular theory of operation, the inclusion of such groups in the chlorine dioxide precursor may correspond or be analogous to the effect of certain buffer components, as is discussed hereinafter. But the invention is fully operable without reference to a specific buffer.

The liquid medium used and the components included therein are selected to have no substantial detrimental effect on the substrate, e.g., contact lens, being disinfected and to allow and even facilitate the disinfection of the substrate. The liquid medium and included components preferably have no substantial detrimental effect on the promoter component being

employed. The liquid medium is preferably aqueous-based. A particularly useful aqueous liquid medium is that derived from saline, e.g., a conventional saline solution. Preferably the precursor aqueous liquid medium and the aqueous liquid medium containing chlorine dioxide have a pH in the range of about 6 to about 10, more preferably about 6.5 to about 8, and still more preferably about 7.5. Such more preferred and still more preferred pH ranges are substantially consistent with the normal physiological pH for humans. Thus, after disinfecting, the disinfected contact lens may be rinsed with saline or chlorine dioxide-containing liquid medium, for example, from the present apparatus, before being placed in the eye. This is in contrast to other systems which require elaborate neutralization procedures before the lens is suitable for placement in the eye.

In order to insure that the pH of the precursor aqueous liquid medium is maintained within the desired range, the precursor aqueous liquid medium may include at least one buffer component. Although any suitable buffer component may be employed, it is preferred to select such component so as not to substantially detrimentally affect the chlorine dioxide. It is preferred that the buffer component be inorganic.

Certain buffer components actually increase or facilitate the rate and/or amount of chlorine dioxide formed from the precursor. Among these buffer components are those which include phosphate functionalities, borate functionalities, carbonate functionalities and mixtures thereof. Particularly increased rates of chlorine dioxide formation are achieved when the buffer component includes phosphate functionalities, borate functionalities and mixtures thereof. Alkali metal and alkaline earth metal

buffer components are advantageously used in the present invention.

Further, in order to avoid possible eye irritation, it is preferred that the presently useful precursor liquid media have an osmolality (a measure of tonicity) of at least about 200 mOsmol/kg, preferably in the range of about 200 to about 350 or about 400 mOsmol/kg. In an especially useful embodiment, the osmolality or tonicity of the precursor liquid medium substantially corresponds to the tonicity of the fluids of the eye, in particular the human eye.

Any suitable ophthalmically acceptable tonicity component or components may be employed, provided that such component or components are compatible with the other ingredients of the precursor liquid medium and do not have deleterious or toxic properties which could harm the eye. Examples of useful tonicity components include sodium chloride, potassium chloride, mannitol, dextrose, glycerin, propylene glycol and mixtures thereof. In one embodiment, the tonicity component is selected from inorganic salts and mixtures thereof.

The amount of ophthalmically acceptable tonicity component utilized can vary widely. In one embodiment, the tonicity component is preferably present in the precursor liquid medium in an amount in the range of about 0.5 to about 0.9 weight/volume percent of the formulation.

Typical of ophthalmically acceptable inorganic salt tonicity components are alkali metal chlorides and alkaline earth metal chlorides, such as sodium chloride, potassium chloride, calcium chloride and magnesium chloride.

One or more additional components can be included in the presently useful precursor liquid media. Such

additional component or components are chosen to impart or provide at least one beneficial or desired property to the liquid media. Such additional components may be selected from components which are conventionally used in one or more contact lens care compositions. Examples of such additional components include cleaning agents, wetting agents, nutrient agents, sequestering agents, viscosity builders, contact lens conditioning agents, antioxidants, and the like. These additional components may each be included in the precursor liquid medium in an amount effective to impart or provide the beneficial or desired property to the liquid medium. For example, such additional components may be included in the presently useful precursor liquid media in amounts similar to the amounts of such components used in other, e.g., conventional, contact lens care products.

Examples of useful wetting agents include polyvinyl alcohol, polyoxamers, polyvinyl pyrrollidone, hydroxypropyl methyl cellulose and mixtures thereof.

Examples of useful sequestering agents include disodium ethylene diamine tetraacetate, alkali metal hexametaphosphate, citric acid, sodium citrate and mixtures thereof.

Examples of useful viscosity builders include hydroxyethyl cellulose, hydroxymethyl cellulose, polyvinyl pyrrolidone, polyvinyl alcohol and mixtures thereof.

Examples of useful antioxidants include sodium metabisulfite, sodium thiosulfate, N-acetylcysteine, butylated hydroxyanisole, butylated hydroxytoluene and mixtures thereof.

After being dispensed from the present apparatus, the chlorine dioxide-containing liquid medium is preferably

used to disinfect a substrate, in particular a contact lens. Thus, the substrate to be disinfected is contacted with the chlorine dioxide-containing liquid medium at conditions to disinfect the substrate.

The disinfecting contacting preferably occurs at a temperature to maintain the liquid medium substantially liquid. For example, when the liquid medium is aqueous-based, it is preferred that the contacting temperature be in the range of about 0°C to about 100°C, and more preferably in the range of about 10°C to; about 60°C. Contacting at or about ambient temperature is very convenient and useful. The contacting preferably occurs at or about atmospheric pressure. This contacting preferably occurs for a time to substantially completely disinfect the substrate being treated. When disinfecting contact lenses, such contacting times can be in the range of about 0.1 hours to about 12 hours or more. After such contacting, the disinfected contact lens may be contacted with, for example, rinsed with and/or soaked in, a substantially chlorine dioxide-free liquid medium, e.g., a conventional saline solution, to remove residual chlorine dioxide from the lens before placing the lens in the wearer's eye.

Various aspects of the present invention are illustrated in the accompanying drawings in which like parts bear like reference numbers.

Brief Description of the Drawings

Fig. 1 is a top front view, in perspective, of an embodiment of the present apparatus.

Fig. 2 is a partial cross-sectional view of the embodiment shown in Fig. 1 taken generally along line 2-2 of Fig. 1.

Fig. 3 is a cross-sectional view of the embodiment

shown in Fig. 1 showing the apparatus being readied for activation.

Fig. 4 is a partial cross-sectional view of the embodiment shown in Fig. 1 showing the apparatus being activated.

Fig. 5 is a partial cross-sectional view of another embodiment of the present apparatus, the left side of the drawing showing the apparatus inactivated and the right side of the drawing showing the apparatus being activated.

Fig. 6 is a partial cross-sectional view of an additional embodiment of the present apparatus, the left side of the drawing showing the apparatus inactivated and the right side of the drawing showing the apparatus being activated.

Fig. 7 is a partial cross-sectional view of a further embodiment of the present apparatus, the left side of the drawing showing the apparatus inactivated and the right side of the drawing showing the apparatus being activated.

Fig. 8 is a partial cross-sectional view of an alternate embodiment of the present apparatus, the left side of the drawing showing the apparatus inactivated and the right side of the drawing showing the apparatus being activated.

Fig. 9 is a partial cross-sectional view of yet another embodiment of the present apparatus, the left side of the drawing showing the apparatus inactivated and the right side of the drawing showing the apparatus being activated.

Fig. 10 is a front plan view, partly in cross-section, of a still further embodiment of the present apparatus showing the apparatus inactivated.

Fig. 11 is a partial cross-sectional view of the apparatus shown in Fig. 10 showing the apparatus being

activated.

Fig. 12 is a front plan view of an alternative embodiment of the present apparatus showing the apparatus inactivated.

Fig. 13 is a top front view, in perspective, of a further additional embodiment of the present apparatus shown in the "as shipped" or inactivated condition.

Fig. 14 is a cross-sectional view of the embodiment shown in Fig. 13 shown in the activated condition.

Fig. 15 is a partial, somewhat schematic view of a further alternate embodiment of the present apparatus shown in the "as shipped" or inactivated condition.

Fig. 16 is a partial cross-sectional view of the apparatus shown in Fig. 15 showing the activation of this apparatus.

Detailed Description of the Drawings

Referring now to the drawings, Figs. 1 to 4 illustrate a chlorine dioxide delivery apparatus or bottle, shown generally at 10, which includes a bottle body 12, a bottle stem 14, a tip component 16, an internal closure component 18, a catalyst element 20 and a bottle cap 22. Each of the components of bottle 10, except for the catalyst element 20, is made of a polymeric material which has no substantial detrimental effect on, and is not substantially detrimentally affected by, either the precursor aqueous liquid medium in bottle 10 or the chlorine-dioxide containing liquid medium dispensed by bottle 10. Each of the components of bottle 10 can be sized appropriately to meet the requirements of the particular application involved. For example, if bottle 10 is to be used to supply chlorine dioxide-containing liquid medium for contact lens disinfecting, bottle body 12 may be sized to hold about 100 cc to about 500 cc or

about 1000 cc or more of precursor liquid medium. About 5 cc to about 10 cc of chlorine dioxide-containing liquid medium can be dispensed to disinfect a pair of contact lenses.

A spacer member 24 is press fitted to bottle stem 14. Alternately, spacer member 24 may be adhesively or otherwise secured to bottle stem 14. In any event, first component 16 is held stationary relative to bottle stem 14. Tip component 16 is fitted into the opening defined by the inner surface 26 of spacer member 24. In the "as shipped" configuration, shown in Fig. 2, a blocking ring 28 is located between ridge 30 of tip component 16 and the top surface 32 of spacer member 24. Blocking ring 28 together with cap 22 act to hold tip component 16 stationary relative to bottle stem 14.

The tip component 16 includes a depending portion 31 which comes in contact with internal closure component 18, as shown in Fig. 2. Tip component 16 also includes an outlet 33 through which chlorine dioxide-containing liquid medium exits bottle 10. Internal closure component 18 includes an upwardly extending hollow projection 34 which, together with upper surface 36 of internal closure component 18, form a space into which catalyst element 20 is placed, for example, during pre-use shipment and storage. With closure component 18 in place, as shown in Fig. 2, liquid medium from the receptacle 38 defined by bottle body 12 is effectively prevented from contacting catalyst component 20.

Closure component 18 includes a downwardly depending projection 40 which includes a radially extending recess 42. Spacer member 24 includes an inwardly extending projection 44 which is sized and adapted to fit into recess 42, as shown in Fig. 2. The combination of

projection 44 in recess 42 acts to resist the movement of closure component 18 relative to spacer member 24. This feature reduces the risk of accidental/premature activation of apparatus 10.

Bottle stem 14 includes an outer surface 48 which is threaded. Bottle cap 22 includes an inner surface 50 which is threaded with threads which engage the threads on outer surface 48 of bottle stem 14. By threading or unthreading bottle cap 22 onto or from bottle stem 14, the outlet 33 can be effectively covered or uncovered, as desired.

The catalyst element 20 is initially located in the space defined by projection 34 and surface 36, as shown in Fig. 2. The catalyst element 20 includes sufficient palladium, for example, about 1% or less to about 10% or more, such as 5% (by weight), calculated as elemental palladium on a catalyst support (for example, made of any suitable polymeric or inorganic oxide, such as alumina, silica and the like) to be effective when placed in receptacle 38 to promote the conversion of chlorine dioxide precursor in the liquid in receptacle 38 into chlorine dioxide, in particular a contact lens disinfecting amount of chlorine dioxide. Catalyst element 20 may be derived using any of a number of conventional techniques for depositing palladium on a substrate.

Receptacle 38 includes a precursor aqueous liquid medium including chlorine dioxide precursor, in particular stabilized chlorine dioxide such as that sold under the trademark Purogene® by BioCide International, Inc. This aqueous liquid medium may contain, for example, about 0.01% to about 0.2% by weight of stabilized chlorine dioxide, and, in addition, an effective amount of a buffering agent, preferably a borate buffering agent, to

maintain the pH of the solution in the range of about 6 to about 10. The aqueous liquid medium may be derived from a conventional saline solution. In any event, the aqueous liquid medium includes an effective amount of a tonicity agent to provide for ophthalmically acceptable tonicity.

The apparatus 10 functions as follows. When it is desired to ship or store the apparatus 10 prior to use, the apparatus is configured in an inactivated state substantially as shown in Fig. 2. Thus, the catalyst element 20 is effectively held or maintained out of contact with the liquid medium in receptacle 38. When it is desired to activate apparatus 10 to produce chlorine dioxide-containing liquid medium, for example, to disinfect a contact lens, the following procedure is implemented. Bottle cap 22 is unthreaded from bottle stem 14 and removed. Blocking ring 28 is removed and discarded so that apparatus 10 has a configuration substantially as shown in Fig. 3. Bottle cap 22 is then threaded onto bottle stem 14. This action urges tip component 16 to move downwardly. The resistance to movement caused by projection 44 in recess 42 is overcome. As bottle cap 22 continues to be threaded onto bottle stem 14, tip component 16 moves downwardly and forces closure component 18 and catalyst element 20 into the liquid medium in receptacle 38. Bottle cap 22 is threaded onto bottle stem 14 until ridge 30 comes in contact with surface 32, as shown in Fig. 4. This contact prevents further downward movement of tip component 16 relative to spacer member 24 and bottle stem 14. At this point, tip assembly 16 is preferably press fitted into spacer member 24. In any event, tip component 16 is substantially stationary relative to spacer member 24 and bottle stem 14.

The presence of catalyst element 20 in the liquid medium in receptacle 38 promotes the generation of chlorine dioxide from the chlorine dioxide precursor present in the liquid medium in receptacle 38.

When it is desired to dispense chlorine dioxide-containing liquid medium from apparatus 10, bottle cap 22 is removed from bottle stem 14, and bottle body 12 is tipped to cause chlorine dioxide-containing liquid medium to flow through outlet 33, for example, into a lens container or other device where contact lens disinfection is to occur.

After sufficient chlorine dioxide-containing liquid medium has been delivered, the bottle body 12 is uprighted. In this manner, the apparatus 10 is ready to be stored, and is available for further use in the future.

Fig. 5 illustrates another embodiment of the present chlorine dioxide delivery apparatus. This embodiment, shown generally at 110, includes a bottle body 112, a bottle stem 114, a tip component 116, an internal closure component 118, a catalyst element 120 and a bottle cap 122. Except as expressly stated herein, each of the components of this other apparatus 110 is structured and sized, and functions in a manner similar to the corresponding component of apparatus 10. The reference numerals of the corresponding components of this other apparatus 110 are increased by 100 relative to the reference numerals of the corresponding components of apparatus 10.

The primary difference between this other apparatus 110 and apparatus 10 relates to the manner in which the apparatus are activated. Bottle cap 122 includes a centrally located recess 54 in which is located a plunger member 56. In the inactivated state of apparatus 110 (the

left side of Fig. 5), the top of plunger member 56 is below the top rim 57 of bottle cap 122. This reduces the risk of accidental/premature activation of apparatus 110. A nozzle element 58 extends through a top opening in tip component 116, which is stationary relative to bottle stem 114. The top end 59 of nozzle element 58 is in contact with plunger 56.

Bottle cap 122 includes an inwardly extending projection 60, and plunger member 56 includes two radially extending recesses 61 and 62. In the inactivated state, projection 60 fits into recess 62, while in the activated state projection 60 fits into recess 61. In this manner, the risk of accidental movement of plunger member 56 is reduced.

Tip component 116 includes a series of longitudinally spaced apart recesses 63. Nozzle element 58 includes two longitudinally spaced apart projections 64, while closure component 118 includes a projection 65. In the inactivated state the two projections 64 and the single projection 65 are each located in a different recess 63. This reduces the risk of accidental activation of apparatus 110. In the activated state, the two projections 64 are each located in a different one of the two lower recesses 63. This feature aids in maintaining the nozzle element 58 in place. Nozzle element 58 includes a top opening 66 which forms the outlet of apparatus 110.

The apparatus 110 functions as follows. When it is desired to ship or store apparatus 110 prior to use, the apparatus is configured in an inactivated state substantially as shown on the left side of Fig. 5. Thus, the catalyst element 120 is effectively held or maintained out of contact with the liquid medium in receptacle 138.

When it is desired to activate apparatus 110 to produce chlorine dioxide-containing liquid medium, for example, to disinfect a contact lens, the following procedure is implemented. With bottle cap 122 in place on bottle stem 114, plunger member 56 is pushed down toward bottle body 112. Such pushing is preferably achieved with human hand pressure. This causes nozzle element 58 to move downwardly and to cause closure element 118 and catalyst element 120 to fall into receptacle 138, as shown on the right hand side of Fig. 5.

When it is desired to dispense chlorine dioxide-containing liquid medium from apparatus 110, bottle cap 122 is removed from bottle stem 114, and bottle body 112 is tipped to cause chlorine dioxide-containing liquid medium to flow through outlet 66, for example, into a lens container or other device when contact lens disinfection is to occur. After sufficient chlorine dioxide-containing liquid medium has been delivered, the bottle body 112 is uprighted. In this manner the apparatus is ready to be stored and/or is available for further use in the future.

Fig. 6 illustrates an additional embodiment of the present chlorine dioxide delivery apparatus. This additional embodiment, shown generally at 210, includes a bottle body 212, a bottle stem 214, a tip component 216, an internal closure component 218, a catalyst element 220, and a bottle cap 222. Except as expressly stated herein, each of the components of this additional apparatus 210 is structured and sized, and functions in a manner similar to the corresponding component of apparatus 10. The reference numerals of the corresponding components of additional apparatus 210 are increased by 200 relative to the reference numerals of the corresponding components of apparatus 10.

The primary difference between this additional apparatus 210 and apparatus 10 relates to the manner in which the apparatus are activated. A spacer member 224 is press fitted to bottle stem 214. Tip component 216 includes an inwardly extending recess 68 which receives a radially inwardly extending projection 69 of spacer member 224. This feature reduces the risk of accidental or premature activation of apparatus 210.

Tip component 216 also includes an inwardly extending recess 70 which is sized and adapted to receive projection 71 of closure component 218. Again, this feature reduces the risk of accidental or premature activation of additional apparatus 210. The upper outer surface of tip component 216 is recessed at 73 to allow the human user to grip tip component more securely.

The additional apparatus 210 functions as follows. When it is desired to ship or store the apparatus 210 prior to use, the apparatus is configured in an inactivated state substantially as shown on the left hand side of Fig. 6. Thus, the catalyst element 220 is effectively held or maintained out of contact with the liquid medium in receptacle 238.

When it is desired to activate additional apparatus 210 to produce chlorine dioxide-containing liquid medium, the following procedure is implemented. Bottle cap 222 is unthreaded from bottle stem 214 and removed. Tip component 216 is pulled, preferably using human hand pressure, generally away from receptacle 238. This action causes closure component 218 and catalyst component 220 to fall into receptacle 238, as shown on the right hand side of Fig. 6. The movement of tip component 216 away from receptacle 238 is limited by the radially outwardly extending end portion 72 of tip component 216 contacting

projection 69 of spacer member 224. If desired, tip component 216 can be moved back toward receptacle 38 so that projection 69 can be again located within recess 68.

When it is desired to dispense chlorine dioxide-containing liquid medium from additional apparatus 210, bottle cap 222 is removed from bottle stem 214, and bottle body 212 is tipped to cause chlorine dioxide-containing liquid medium to flow through outlet 233, for example, into a lens container or other device where contact lens disinfection is to occur.

After sufficient chlorine dioxide-containing liquid medium has been delivered, the bottle body 212 is uprighted. In this manner the additional apparatus 210 is ready to be stored and is available for further use in the future.

Fig. 7 illustrates a further embodiment of the present chlorine dioxide delivery apparatus. This embodiment, shown generally at 310, includes a bottle body 312, a bottle stem 314, a tip component 316, an internal closure component 318 and a catalyst element 320. Except as expressly stated herein, each of the components of this further apparatus 310 is structured and sized, and functions in a manner similar to the corresponding component of apparatus 10. The reference numerals of the corresponding components of further apparatus 310 are increased by 300 relative to the reference numerals of the corresponding components of apparatus 10.

The primary difference between further apparatus 310 and apparatus 10 relates to the manner in which the apparatus are activated. An elongated nozzle element 74 extends through a top opening in tip component 316, which is stationary relative to bottle stem 314. The bottom end 75 of elongated nozzle element 74 is in contact with, or

in proximity to, the top of internal closure component 318 when further apparatus 310 is inactivated.

Tip component 316 includes a radially inwardly extending projection 76, and internal closure component 318 includes a correspondingly sized recess 77. In the inactivated state, the projection 76 is located in the recess 77. This reduces the risk of accidental activation of apparatus 310. In the activated state, the inwardly extending recess 78 on elongated nozzle element 74 receives and holds projection 76. This feature aids in maintaining the elongated nozzle element 74 in place. Elongated nozzle element 74 includes a top opening 79 which forms the outlet of apparatus 310.

The apparatus 310 functions as follows. When it is desired to ship or store apparatus 310 prior to use, the apparatus is configured in an inactivated state substantially as shown on the left side of Fig. 7. Thus, the catalyst element 320 is effectively held or maintained out of contact with the liquid medium in receptacle 338. A bottle cap (not shown) substantially similar to cap 22, may be included as a separate component.

When it is desired to activate apparatus 310 to produce chlorine dioxide-containing liquid medium, for example, to disinfect a contact lens, the following procedure is implemented. Elongated nozzle element 74 is pushed down toward bottle body 312. Such pushing is preferably achieved with human hand pressure. This causes elongated nozzle element 74 to move downwardly and to cause closure component 318 and catalyst element 320 to fall into receptacle 338, as shown on the right hand side of Fig. 7.

When it is desired to dispense chlorine dioxide-containing liquid medium from apparatus 310, the bottle

cap is removed from bottle stem 314, and bottle body 312 is tipped to cause chlorine dioxide-containing liquid medium to flow through outlet 79, for example, into a lens container or other device where contact lens disinfection is to occur. After sufficient chlorine dioxide-containing liquid medium has been delivered, the bottle body 312 is uprighted. In this manner the apparatus is ready to be stored and/or is available for further use in the future.

Fig. 8 illustrates an alternate embodiment of the present chlorine dioxide delivery apparatus. This embodiment, shown generally at 410, includes a bottle body 412, a bottle stem 414, a tip component 416, an internal closure component 418, a catalyst element 420 and a bottle cap 422. Except as expressly stated herein, each of the components of this alternate apparatus 410 is structured and sized, and functions in a manner similar to the corresponding component of apparatus 10. The reference numerals of the corresponding components of alternate apparatus 410 are increased by 400 relative to the reference numerals of the corresponding components of apparatus 10.

The primary differences between this alternate apparatus 410 and apparatus 10 involve the manner in which the apparatus are activated and the structure of catalyst element 420. This catalyst element 420 is made of a polymeric film, such as a film of polyethylene terephthalate, on which is deposited, for example using any one of a number of conventional deposition techniques, an active metal component, such as palladium metal. This palladium-containing film is placed around a central element 80 of closure component 418 in such a manner so that the film forms radially extending folds (accordion-like folds) around the central element. The enlarged top

81 of central element 80 acts to keep catalyst component 420 coupled to closure component 418. In the activated state, closure component 418 and catalyst component 420 together have sufficient weight to sink to and stay at or near the bottom of receptacle 438.

In the "as shipped" configuration, alternate apparatus 410 is equipped with a tear-away strip 88 located between and in contact with both the bottle cap 422 and the bottle body 412. Strip 88 serves at least two functions. With strip 88 in place, the consumer has assurance that alternate apparatus 410 has not been tampered with. Also, with strip 88 in place, bottle cap 422 is prevented from moving toward receptacle 438, thus keeping catalyst element 420 separated from receptacle 438. Strip 88, which includes a relatively thin area near bottle cap 422, can be easily torn away by pulling on finger tab 89. Once strip 88 is removed bottle cap 422 can be threaded toward receptacle 438. It should be noted that strip 88, or a similarly structured element, can be used in conjunction with many of the herein illustrated embodiments of the present system.

Tip component 416 is structured to be moveable toward receptacle 438 along the longitudinal axis 81 of alternate apparatus 410. Once this movement has occurred, the sizing of the components of alternate apparatus 420 is such that tip component 416 is
maintained stationary relative to bottle stem 414.

Alternate apparatus 410 functions as follows. When it is desired to ship or store apparatus 410 prior to use, the apparatus is configured in an inactivated state substantially as shown on the left side of Fig. 8. Thus, the catalyst element 420 is effectively held or maintained out of contact with the liquid medium in receptacle 438.

When it is desired to activate apparatus 410 to produce chlorine dioxide-containing liquid medium, for example, to disinfect a contact lens, the following procedure is implemented. Strip 88 is manually removed. Bottle cap 422 is threaded onto bottle stem 414. This causes tip component 416 to move downwardly and to cause catalyst element 420 and closure component 418 to fall into receptacle 438, as shown on the right hand side of Fig. 8.

When it is desired to dispense chlorine dioxide-containing liquid medium from apparatus 410, bottle cap 422 is removed from bottle stem 414, and bottle body 412 is tipped to cause chlorine dioxide-containing liquid medium to flow through outlet 432, for example, into a lens container or other device when contact lens disinfection is to occur. After sufficient chlorine dioxide-containing liquid medium has been delivered, the bottle body 412 is uprighted. In this manner the apparatus is ready to be stored and/or is available for further use in the future.

Fig. 9 illustrates yet another embodiment of the present chlorine dioxide delivery apparatus. This embodiment, shown generally at 510, includes a bottle body 512, a bottle stem 514, a tip component 416, a catalyst element 520 and a bottle cap 522. Except as expressly stated herein, each of the components of this yet another apparatus 510 is structured and sized, and functions in a manner similar to the corresponding component of apparatus 10. The reference numerals of the corresponding components of this apparatus 510 are increased by 500 relative to the reference numerals of the corresponding components of apparatus 10.

The primary differences between this apparatus 510 and apparatus 10 relate to the structure of tip component 516 and catalyst component 520, and to the manner in which the apparatus are activated. Tip component 516 includes a compressible or bellows-like side wall 82. Tip component 516 also includes a non-compressible, lower sidewall portion 83 which is force fitted into the annular space defined by bottle stem 514, and a breakable bottom end wall 84. The lower portion of tip component 516 is substantially stationary relative to bottle stem 514, which the top portion of tip component 516 is movably relative to bottle stem 514 by compressing compressible sidewall 82.

Catalyst element 520 is structured substantially similarly to catalyst element 420, and is carried by a carrier component 85 which also acts to insure that, upon activation, catalyst element 520 is located at or near the bottom of receptacle 538. Carrier component 85 includes a pointed end 86 which, when apparatus 510 is inactivated, is pointed toward breakable bottom end wall 84. During activation, pointed end 86 facilitates the breaking of bottom end wall 84. Tip component 516 includes a downwardly depending solid element 87 which, during activation, contacts carrier component 85 and also facilitates the breaking of bottom end wall 84.

The apparatus 510 functions as follows. When it is desired to ship or store apparatus 510 prior to use, the apparatus is configured in an inactivated state substantially as shown on the left side of Fig. 9. Thus, the catalyst element 520 is effectively held or maintained out of contact with the liquid medium in receptacle 538.

When it is desired to activate apparatus 510 to produce chlorine dioxide-containing liquid medium, for

example, to disinfect a contact lens, the following procedure is implemented. Bottle cap 522 is threaded onto bottle stem 514. This causes compressible sidewall 82 to compress, solid element 87 to contact carrier component 85 which is moved downwardly to break bottom end wall 84. This, in turn, causes carrier component 85 and catalyst element 520 to fall into apparatus 538, as shown on the right hand side of Fig. 9. In the compressed state, sidewall 82 exerts an upward force on tip component 516 which facilitates forming an effective seal between the bottle cap 522 and tip component 516 when bottle cap 522 is threaded onto bottle stem 514. This effectively seals outlet 533 from exposure to the atmosphere during periods of non-use of apparatus 510.

When it is desired to dispense chlorine dioxide-containing liquid medium from apparatus 510, bottle cap 522 is removed from bottle stem 514, and bottle body 512 is tipped to cause chlorine dioxide-containing liquid medium to flow through outlet 532, for example, into a lens container or other device when contact lens disinfection is to occur. After sufficient chlorine dioxide-containing liquid medium has been delivered, the bottle body 512 is uprighted. In this manner the apparatus is ready to be stored and/or is available for further use in the future.

Referring now to Figs. 10 and 11, a still further apparatus, shown generally at 90, includes a main bottle portion 91, a cup-like element 92, a catalyst element 93, a hollow tip 94 and a bottle cap 95. Except for catalyst element 93, each of the components of apparatus 90 may be made of suitable polymeric materials.

Main bottle portion 91 defines a receptacle 96 which functions to hold liquid medium containing chlorine

dioxide precursor, in much the same manner as receptacle 38. Main bottle portion 91 includes a breakable bottom end wall 97 and a lower, outer threaded surface 98.

Cup-like element 92 includes an inner threaded surface 99. The threaded surfaces 98 and 99 are sized and configured so that the threads can be intermeshed to allow cup-like element 92 to be threaded onto main bottle portion 91. Extending upwardly from the bottom end wall 100 of cup-like element 92 is sharp edge element 101.

Catalyst element 93 is compositionally similar to catalyst element 20 and may be adhesively secured or secured in any other appropriate manner to cup-like element 92.

Hollow tip 94 is in fluid communication with receptacle 96 and includes an outlet (not shown) through which liquid medium, in particular chlorine dioxide-containing liquid medium, exits apparatus 90. Bottle cap 95 covers hollow tip 94 and the outlet during periods of non-use.

Apparatus 90 functions as follows. When it is desired to store or ship the apparatus 90 prior to use, the apparatus is configured in an inactivated state substantially as shown in Fig. 10. Thus, the catalyst element 93 is effectively held or maintained out of contact with the liquid medium in receptacle 96.

When it is desired to activate apparatus 90 to produce chlorine dioxide-containing liquid medium, for example, to disinfect the contact lens, the following procedure is implemented. Cup-like element 92 is threaded onto main bottle portion 91. In so doing, sharp edge element 101 punctures breakable end wall 97, as shown in Fig. 11, causing the liquid in receptacle 96 to come in contact with catalyst element 93. This liquid

medium/catalyst element contacting promotes the generation of chlorine dioxide from the chlorine dioxide precursor present in the liquid medium in receptacle 96.

When it is desired to dispense chlorine dioxide-containing liquid medium from apparatus 90, cap 95 is removed from hollow tip 94 and the main bottle portion 91 is tipped to cause chlorine dioxide-containing liquid medium to flow through the outlet, for example into a lens container or other device where contact lens disinfection is to occur.

After sufficient chlorine dioxide-containing liquid medium has been delivered, the main bottle portion 91 is uprighted, onto cup-like element 92 which remains in place threaded on the main bottle portion 91. Cap 95 is again used to cover hollow tip 94. In this manner, the apparatus 90 is ready to be stored and is available for further use in the future.

Referring now to Fig. 12, an alternative apparatus, shown generally at 102, includes a flexible bottle body 103, a breakable seal 104, a catalyst element 105 and a tip 106. Except for catalyst element 105, each of the components of apparatus 102 may be made of suitable polymeric materials.

Flexible bottle body defines a receptacle 107 which functions substantially similarly to the receptacle 38, previously described. Catalyst element 105 is compositionally similar to catalyst element 20. With the apparatus 102 in the inactivated state, receptacle 107 is defined by the flexible bottle body 103 and breakable seal 104. Breakable seal 104 effectively keeps the precursor liquid medium in receptacle 107 out of contact with catalyst element 105.

Breakable seal 104 can be made in any suitable manner to be broken by human intervention, for example, upon the imposition of hand pressure to the upper portion of the flexible bottle body 103. The breakable seal 104 can be made using conventional and well known techniques. For example, seal 104 can be a heat seal. Alternately, seal 104 can involve a clip or other mechanical assembly to separate the liquid in the upper portion of flexible bottle body 103 from the catalyst 105. Removing the clip or other assembly breaks the seal and allows precursor liquid medium/catalyst element contacting.

Tip 106 includes an outlet through which liquid, in particular chlorine dioxide-containing liquid medium from receptacle 107, can exit the apparatus 102. Tip 106 is a one-way valve which allows liquid to flow out of receptacle 107 but does not permit liquid or gas (air) to be passed into receptacle 107.

The apparatus 102 functions as follows. When it is desired to ship or store the apparatus 102 prior to use, the apparatus is configured in an inactivated state substantially as shown in Fig. 12. Thus, the catalyst element 105 is effectively held or maintained out of contact with the liquid medium in receptacle 107.

When it is desired to activate apparatus 102 to produce chlorine dioxide-containing liquid medium, for example, to disinfect a contact lens, the following procedure is implemented. Tip 106 is positioned so as to prevent liquid from leaving through the outlet in tip 106. Flexible bottle body is subjected to human hand pressure sufficient to cause breakable seal 104, for example, a temporary heat seal, to rupture, thus allowing the liquid medium in receptacle 107 to come in contact with the catalyst element 105. This liquid medium/catalyst element

contacting promotes the generation of chlorine dioxide from the chlorine dioxide precursor present in the liquid medium in receptacle 107.

When it is desired to dispense chlorine dioxide-containing liquid medium from apparatus 102, tip 106 is positioned to allow liquid from receptacle 107 to exit the apparatus 102. The flexible bottle body 103 is tipped and subjected to human hand squeezing to cause chlorine dioxide-containing liquid medium to flow through tip 106, for example, into a lens container or other device where contact lens disinfection is to occur.

After sufficient chlorine dioxide-containing liquid medium has been delivered, the hand pressure on flexible bottle body 103 is removed and the flexible bottle body 103 is uprighted. The tip 106 is positioned to prevent liquid from receptacle 107 from exiting through tip 106. In this manner the apparatus 102 is ready to be stored, and is available for further use in the future.

Referring now to Figs. 13 and 14, a chlorine dioxide delivery apparatus, shown generally at 610, includes a bottle body 612, a bottle stem 614, a catalyst element 620, a bottle cap 622 and a shipping cap 623. Except as expressly stated herein, each of the components of this apparatus 610 is structured and sized and functions in a manner similar to the corresponding component of apparatus 10. The reference numerals of the corresponding components of apparatus 610 are increased by 600 relative to the reference numerals of the corresponding components of apparatus 10.

The primary difference between the apparatus 610 and apparatus 10 relates to the manner in which the apparatus are shipped and activated. The apparatus 610 is shipped as two components, as shown in Fig. 13. Thus, apparatus

610 is shipped with bottle body 612 capped by shipping cap 623. The reservoir 638 defined by bottle body 612 is shipped filled with precursor liquid medium. The bottle cap 622 and catalyst element 620 are joined by rod member 625. This sub-assembly is shipped packaged in a plastic film envelope 627. Shipping cap 623 includes no outlet, and is threaded onto bottle stem 614 to isolate the liquid medium in receptacle 638.

Bottle cap 622 includes an outlet 629 and a cover 631 which is attached to the bottle cap and can be opened or closed to open or close the outlet.

The apparatus 610 functions as follows. When it is desired to ship the apparatus 610 prior to use, the apparatus is configured in an inactivated state substantially as shown in Fig. 13. Thus, the catalyst element 620 is effectively held or maintained out of contact with the liquid medium in receptacle 638.

When it is desired to activate apparatus 610 to produce chlorine dioxide-containing liquid medium, for example, to disinfect a contact lens, the following procedure is implemented. Shipping cap 623 is removed from bottle stem 614. The sub-assembly including bottle cap 622, rod element 625 and catalyst element 620 is removed from envelope 627. Catalyst element 620 is then placed in receptacle 638 and bottle cap 622 is threaded onto bottle stem 614. In this manner, catalyst element 620 is placed in contact with the liquid medium in receptacle 638 to promote the generation of chlorine dioxide.

When it is desired to dispense chlorine dioxide-containing liquid medium from apparatus 610, cover 631 is opened to open outlet 629. Bottle body 612 is then tipped to cause chlorine dioxide-containing liquid to flow

through outlet 629, for example, into a lens container or other device where contact lens disinfection is to occur. After sufficient chlorine dioxide-containing liquid medium has been delivered, the bottle body 612 is uprighted and cover 631 is closed to close outlet 629. In this manner, the additional apparatus 610 is ready to be stored and is available for further use in the future.

Referring to Figs. 15 and 16, an embodiment of the present apparatus, shown generally at 710, includes a bottle body 712, a bottle stem 714, a catalyst element 720 and a bottle cap 722. Except as expressly stated herein, each of the components of this apparatus 710 is structured and sized, and functions in a manner similar to the corresponding component of apparatus 10. The reference numerals of the corresponding components of apparatus 710 are increased by 700 relative to the reference numerals of the corresponding components of apparatus 10.

The primary differences between this apparatus 710 and apparatus 10 relate to the structure of bottle cap 722 and to the manner in which the apparatus are shipped and activated. Bottle cap 722 is structured and functions in a manner similar to bottle cap 622, discussed previously. Apparatus 710 is shipped as two separate components, as shown in Fig. 15. Thus, bottle body 712 with receptacle 738 filled with precursor liquid medium, and capped with bottle cap 722 is shipped as a single component. An additional cap 723 is shipped in a plastic film envelope 725. Additional cap 723 is shipped with catalyst element 720 fitted into a space in the dome of cap 723. Further, the open bottom of additional cap 723 is sealed closed with sealing member 108 to further isolate catalyst element 720 from the environment during shipment.

The additional apparatus 710 functions as follows. When it is desired to ship the apparatus 710 prior to use, the apparatus is configured in an inactivated state, substantially as shown in Fig. 15. Thus, the catalyst element 720 is effectively held or maintained out of contact with the liquid medium in receptacle 738.

When it is desired to activate apparatus 710 to produce chlorine dioxide-containing liquid medium, the following procedure is implemented. Additional cap 723 is removed from envelop 725 and sealing member 108 is removed. Bottle cap 722 is unthreaded from bottle stem 714 and removed. Additional cap 723 is placed over bottle stem 714. Using human hand pressure on the top of additional cap 723, catalyst element 720 is dislodged from additional cap 723 and allowed to fall into receptacle 738, as shown in Fig. 16. The presence of catalyst element 720 in receptacle 738 promotes the generation of chlorine dioxide from the liquid medium in receptacle 738. Additional cap is removed from bottle stem 714 and bottle cap 722 is rethreaded onto bottle stem 714.

When it is desired to dispense chlorine dioxide-containing liquid medium from apparatus 710, the cover 731 of bottle cap 722 is opened to open the outlet in cap 722. Bottle body 712 is tipped to cause chlorine dioxide-containing liquid medium to flow through this outlet, for example, into a lens container or other device where contact lens disinfection is to occur. After sufficient chlorine dioxide-containing liquid medium has been delivered, the bottle body 712 is uprighted and the cover 731 is closed to close the outlet in bottle cap 722. In this manner, the apparatus 710 is ready to be stored and/or is available for further use in the future.

While this invention has been described with respect to various specific examples and embodiments, it is to be understood that the invention is not limited thereto and that it can be variously practiced within the scope of the following claims.

WHAT IS CLAIMED IS:

1. An apparatus for dispensing an useful product comprising

a first container section defining a receptacle adapted for holding a first component, said reservoir including an outlet conduit through which said useful product exits said receptacle;

a second container section adapted to carry, or to define a space in which is contained at least a portion of, a second component effective when contacted with said first component, to generate or promote the generation of said useful product; and

isolation means when inactivated acting to effectively keep said second component out of contact with said first component in said receptacle, said isolation means being capable of being activated to act to facilitate the contacting of said second component and said first component in said receptacle.

2. The apparatus of claim 1 wherein said second component when said isolation means is inactivated is located in said outlet conduit and after said isolation means is activated is located in said receptacle.

3. The apparatus of claim 2 wherein said second container section is moveable relative to said first container section to activate said isolation means.

4. The apparatus of claim 3 which further comprises a removable block member located in relation to said second container section and said first container section so as to prevent movement of said second container section relative to said first container section to activate said

isolation means.

5. The apparatus of claim 3 wherein at least a portion of said second container section is located within said first container section and said first container section includes a first threaded surface, said apparatus further comprising a removable cap including a second threaded surface, the threads of said first and second threaded surfaces being mutually engageable so that the threading of said second threaded surface onto said first threaded surface acts to move said second container section relative to said first container section to activate said isolation means.

6. The apparatus of claim 1 wherein said first container section and said isolation means are structured to resist activation of said isolation means.

7. The apparatus of claim 1 which further comprises a plunger member adapted to move said isolation means relative to said first container section in response to an applied force to activate said isolation means.

8. The apparatus of claim 7 which includes a removable cap adapted to cover at least a portion of said second container section during periods of non-use of said apparatus, said removable cap including a cap body and said plunger member.

9. The apparatus of claim 8 wherein said cap body and said plunger member are structured to resist movement of said plunger member relative to said cap body after said isolation means is activated.

10. The apparatus of claim 3 wherein said second container section includes a longitudinal axis and is moveable along said longitudinal axis in the direction generally away from said receptacle to activate said isolation means.

11. The apparatus of claim 10 wherein said first container section and said second container section are structured to limit the movement of said second container section relative to said first container section along said longitudinal axis in at least one of the direction generally away from said receptacle and the direction generally toward said receptacle.

12. The apparatus of claim 2 which further comprises a nozzle element which extends into said outlet and into said second container section and provides a path through which said useful product exits said apparatus, said nozzle element being moveable relative to said first container section to activate said isolation means.

13. The apparatus of claim 12 wherein said first container section and said nozzle element are structured to resist movement of said nozzle element relative to said first container section after activation of said isolation means.

14. The apparatus of claim 2 wherein said second container section is compressible to activate said isolation means.

15. The apparatus of claim 14 wherein said isolation means includes a sealed barrier which is activated by

being unsealed.

16. The apparatus of claim 15 wherein said sealed barrier is secured to said second container section.

17. The apparatus of claim 1 which comprises a barrier which is a component of both said first container section and said isolation means, and said isolation means includes a breaking element adapted to break said barrier to activate said isolation means.

18. The apparatus of claim 17 wherein said first container section includes a threaded surface, and said second container section includes a threaded surface, the threads of said two threaded surfaces being mutually engageable to threadably secure said second container section to said first container section, said second container section carrying said second component and being adapted to cause the breaking of said barrier as said second container section is threaded onto said first container section.

19. The apparatus of claim 18 wherein said second container section carries said breaking element.

20. The apparatus of claim 1 wherein said isolation means includes a seal adapted to be broken to allow said first component from said receptacle to contact said second component.

21. The apparatus of claim 20 wherein at least a portion of said first container section is flexible, and said seal is adapted to be broken by applying hand

pressure to said first container section.

22. The apparatus of claim 1 wherein said second component is secured to said second container section and is adapted to extend into said receptacle when said isolation means is activated.

23. The apparatus of claim 22 wherein said second container section includes an outlet port through which said useful product can pass, and a cover adapted to cover said outlet port when said isolation means is activated.

24. The apparatus of claim 22 wherein said isolation means includes a shipping cap adapted to be removably secured to said first container section during shipment and before use of said apparatus, said receptacle including said first component during said shipment.

25. The apparatus of claim 1 wherein said second component is adapted to be shipped secured to said second container section and to be released into said receptacle in response to a releasing force being applied to said second container section when said second container section is placed over said outlet conduit.

26. The apparatus of claim 25 wherein said second container section includes a recess into which said second component is placed, said recess being deformable and said releasing force acts to deform said recess.

27. The apparatus of claim 25 wherein said isolation means includes a cap adapted to be removably secured to said first container section during shipment, said

receptacle including said first component during said shipment.

28. The apparatus of claim 25 wherein said cap includes an outlet port through which said useful product can pass, and a cover adapted to cover said outlet port.

29. The apparatus of claim 1 wherein said useful product is chlorine dioxide-containing liquid medium, said first component is liquid medium containing chlorine dioxide precursor, and said second component is a promoter component effective to promote the generation of the chlorine dioxide-containing liquid medium when contacted with the liquid medium containing chlorine dioxide precursor.

30. The apparatus of claim 29 wherein said promoter component includes a transition metal component in an amount effective to promote the generation of a liquid medium containing contact lens disinfecting amount of chlorine dioxide from the liquid medium containing chlorine dioxide precursor present in said receptacle.

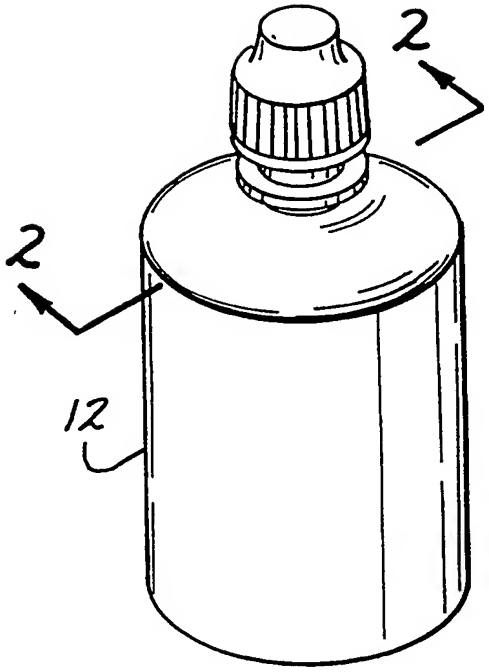
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Fig. 1

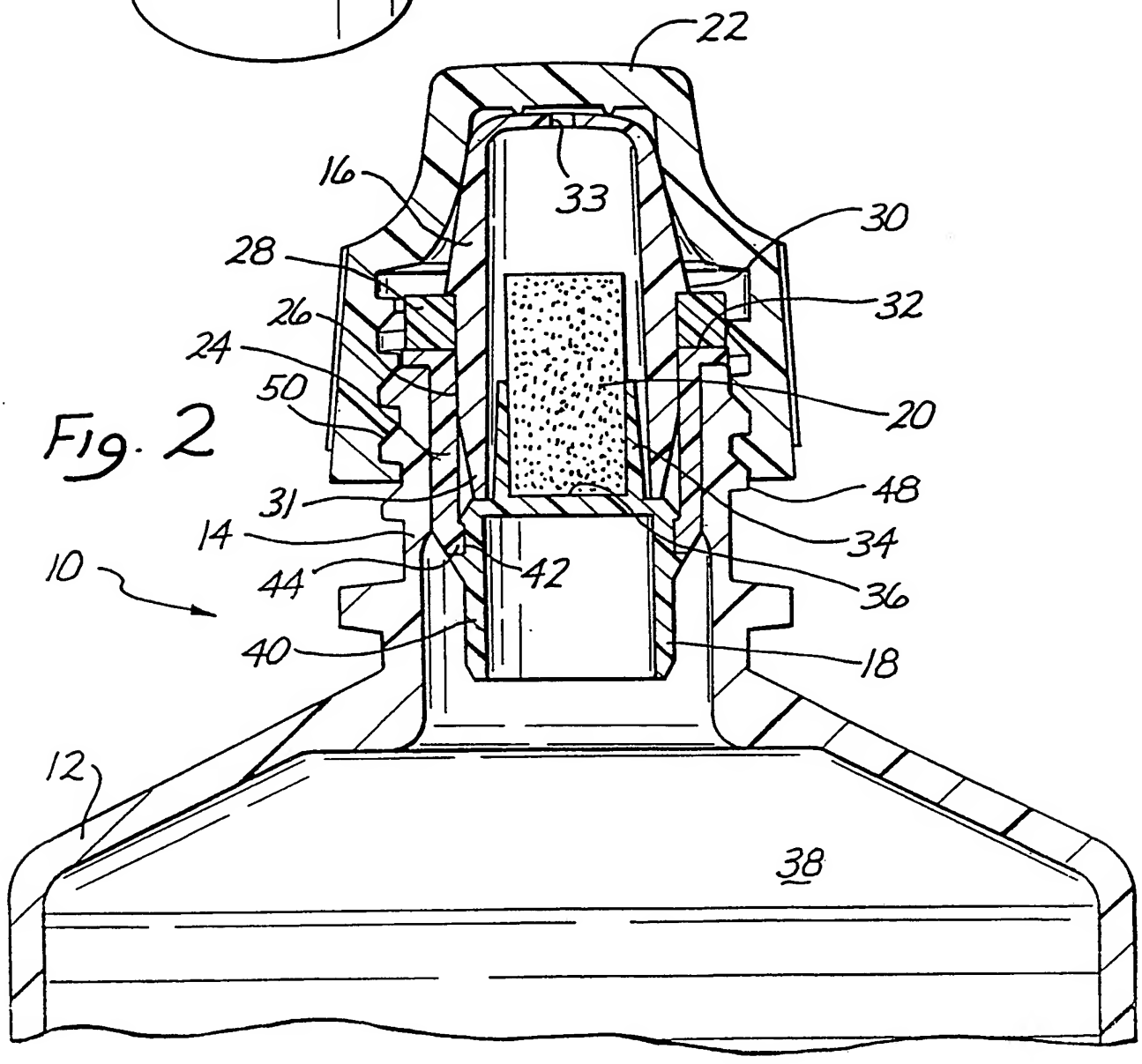
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Fig. 2

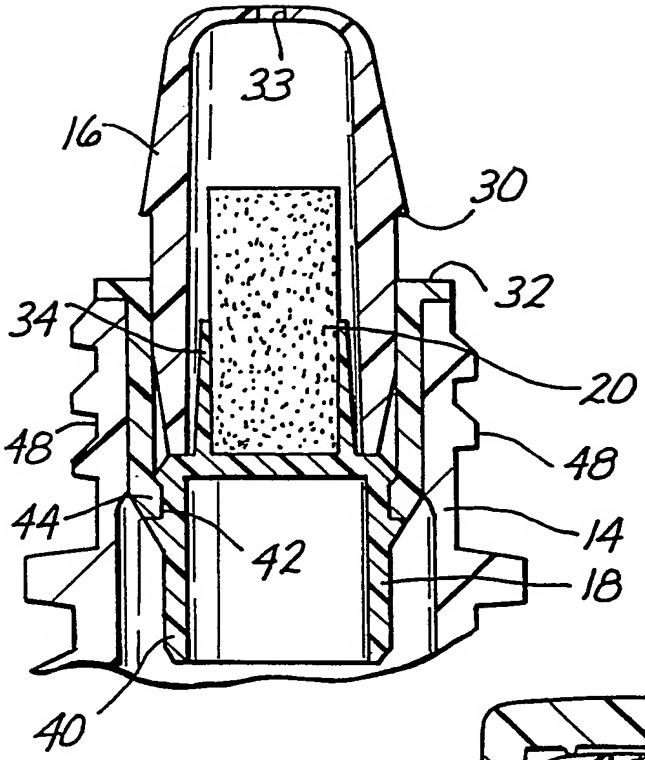
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Fig. 3

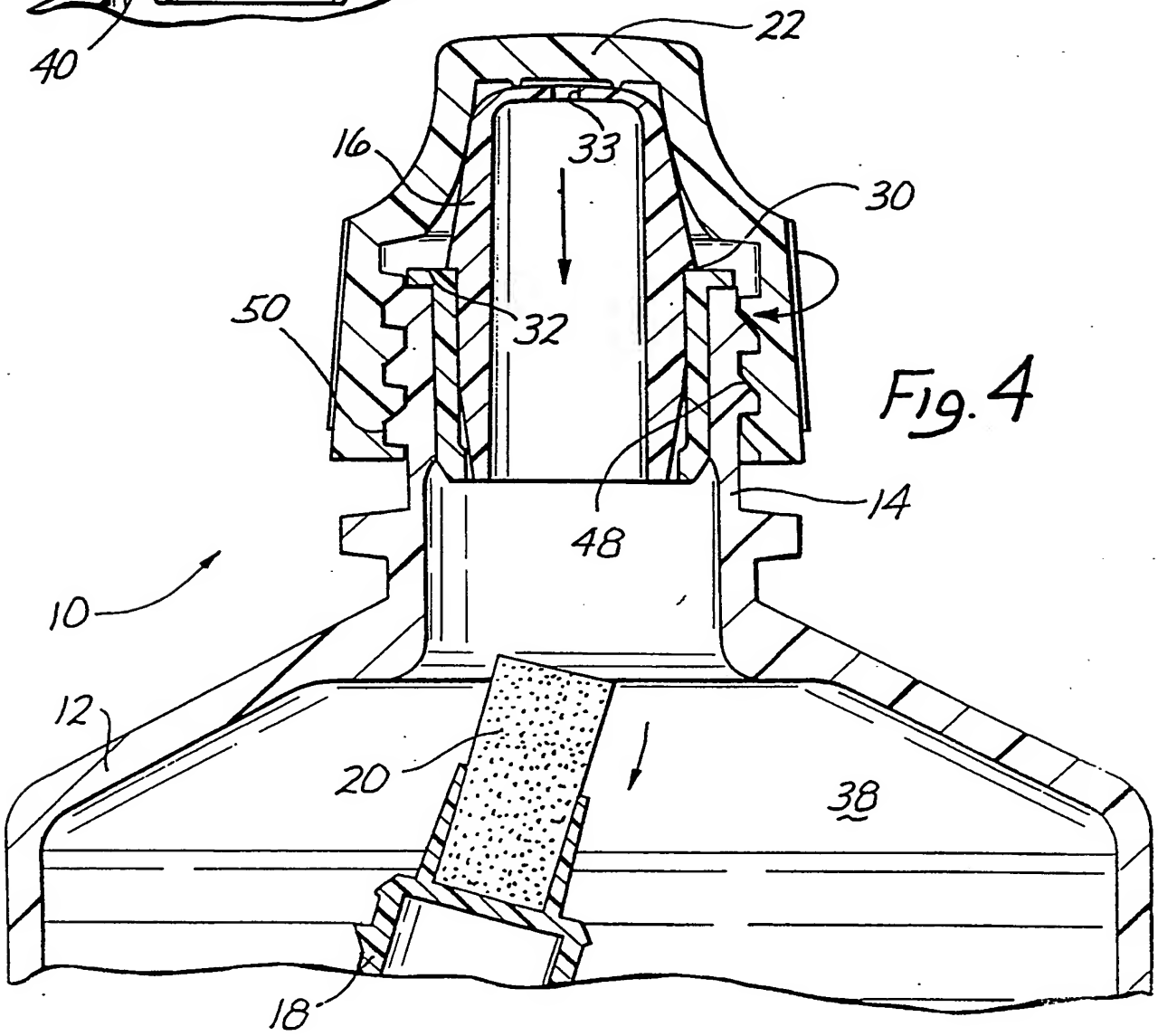
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Fig. 4

Fig. 6

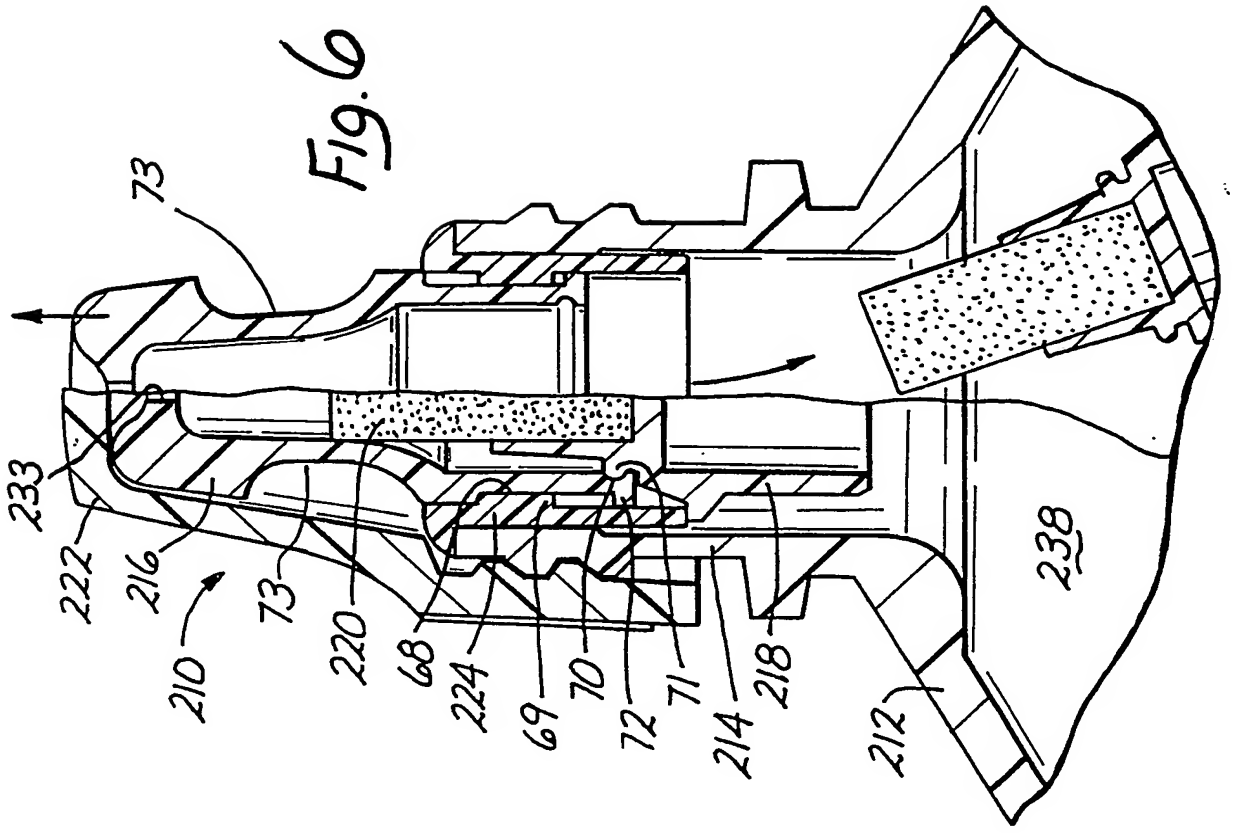
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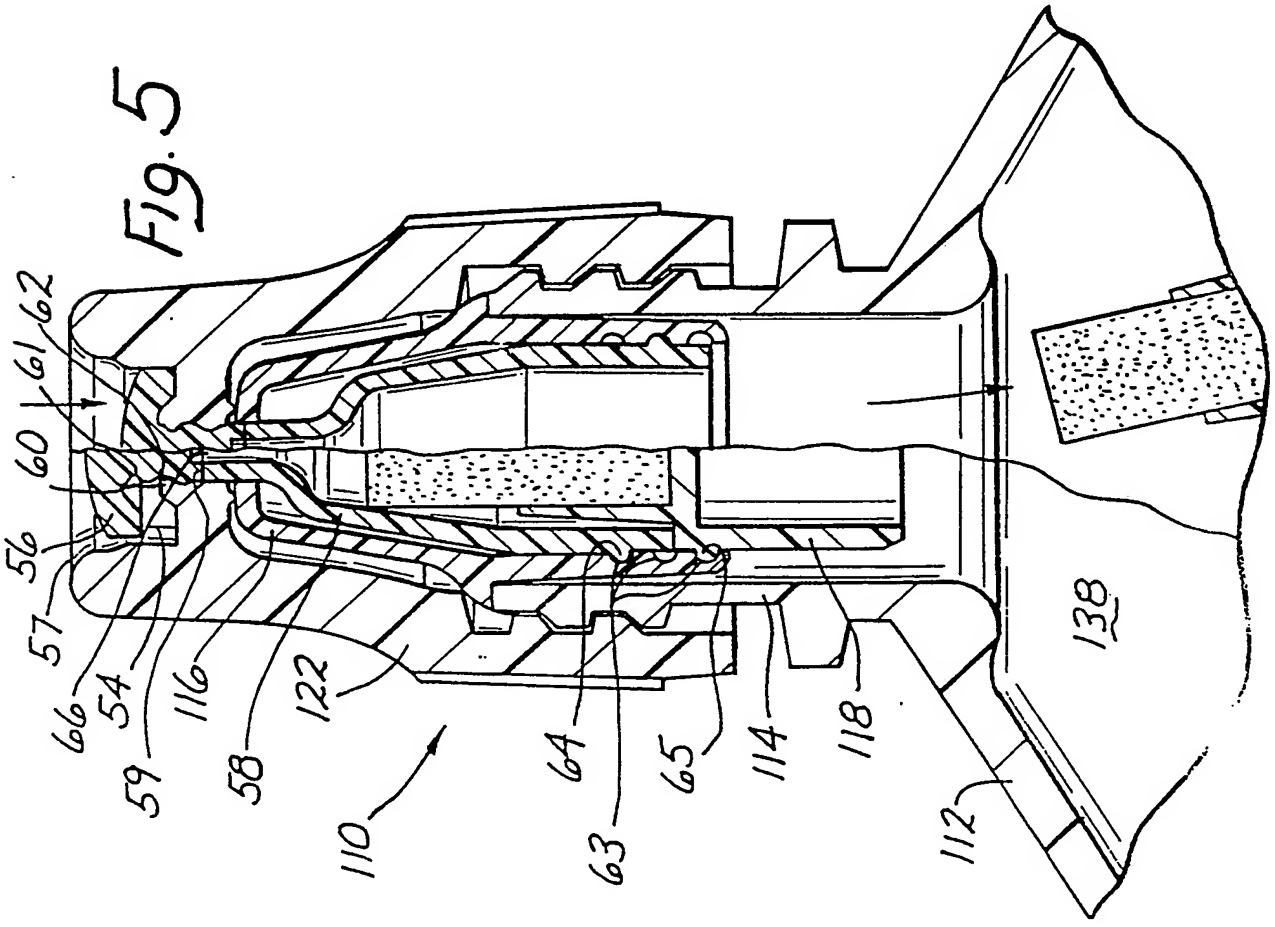
Fig. 5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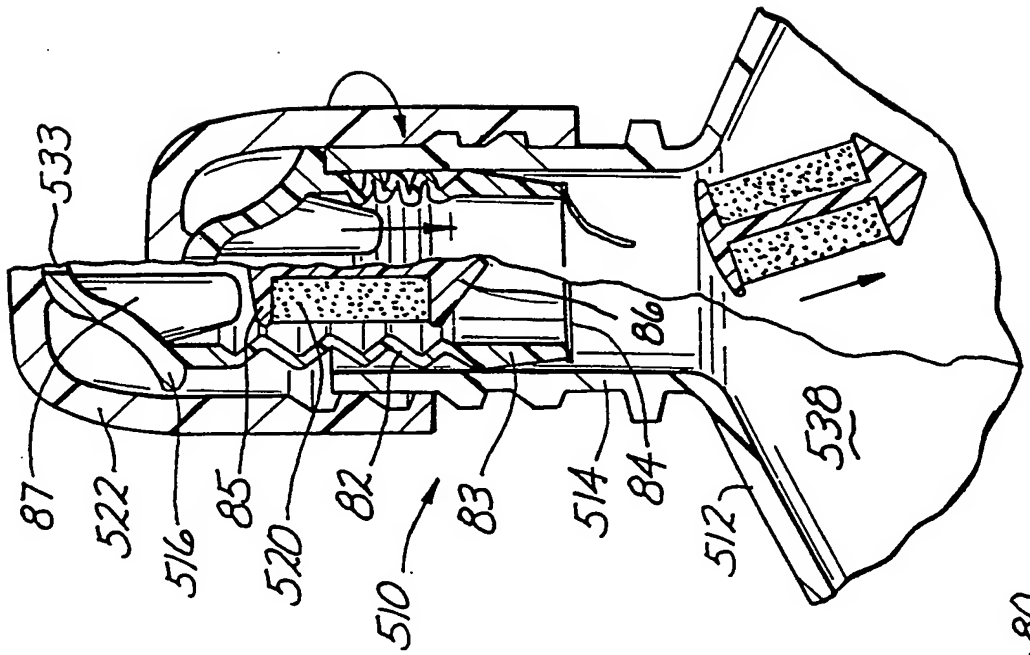


Fig. 9

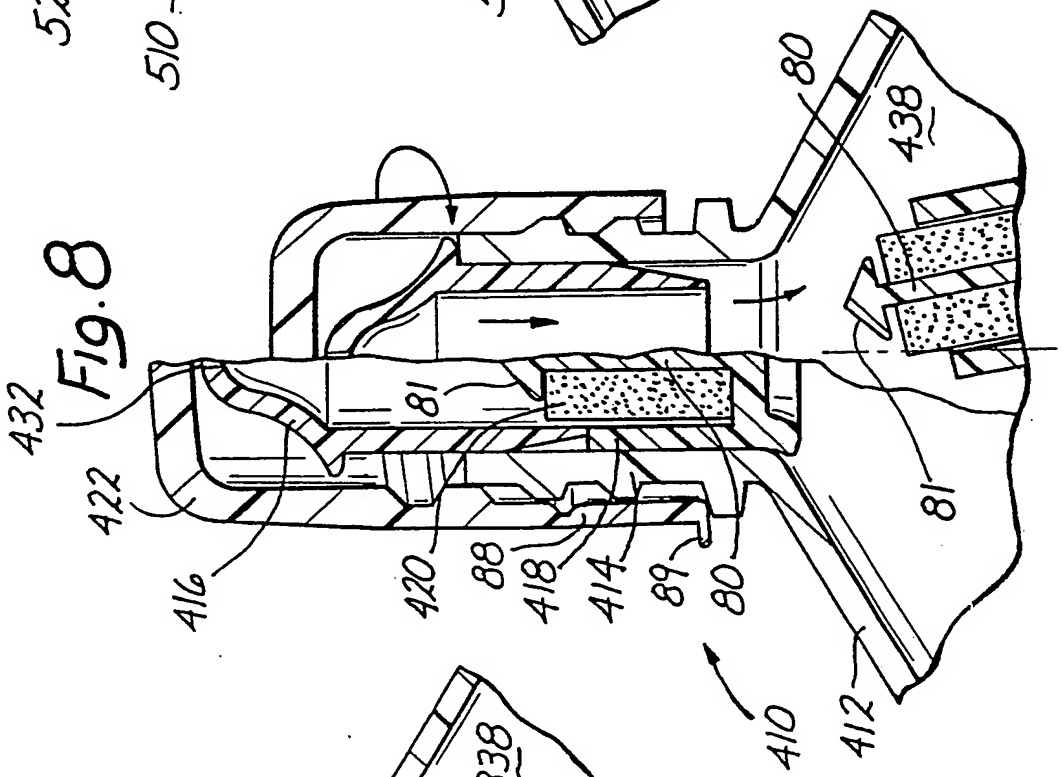


Fig. 8

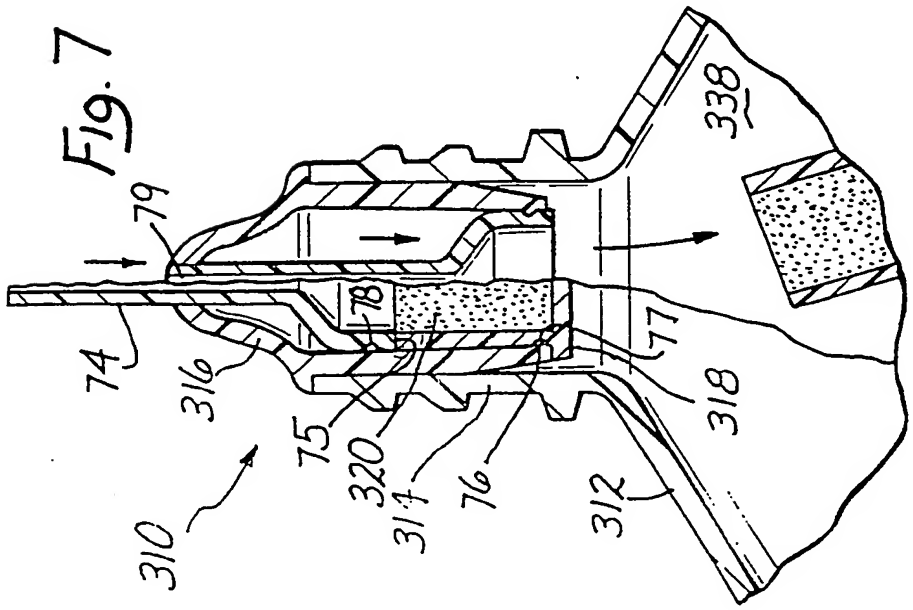


Fig. 7

Fig. 10

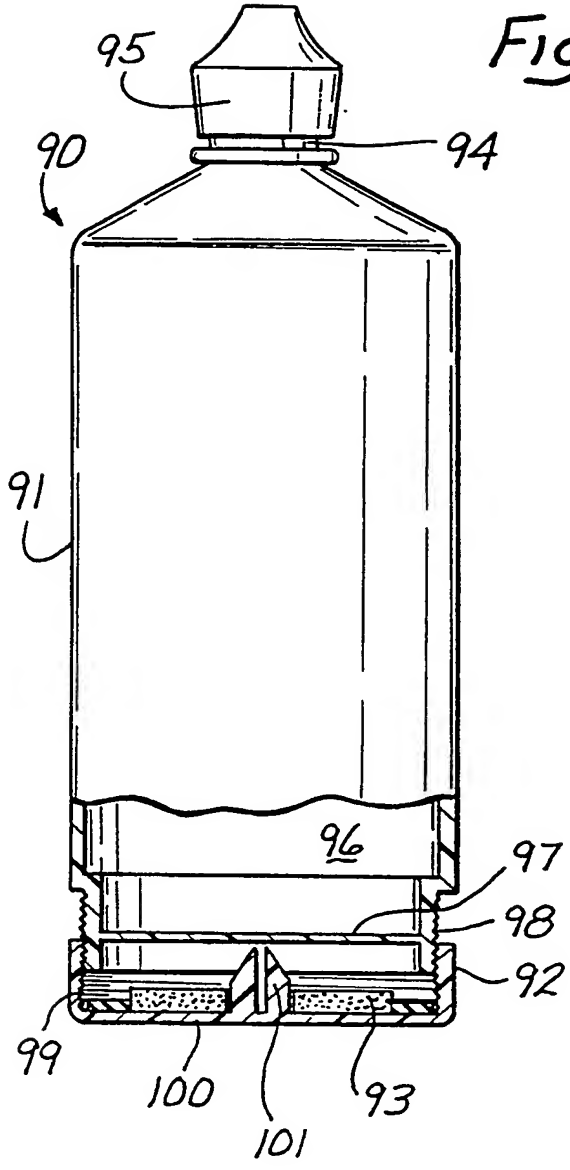
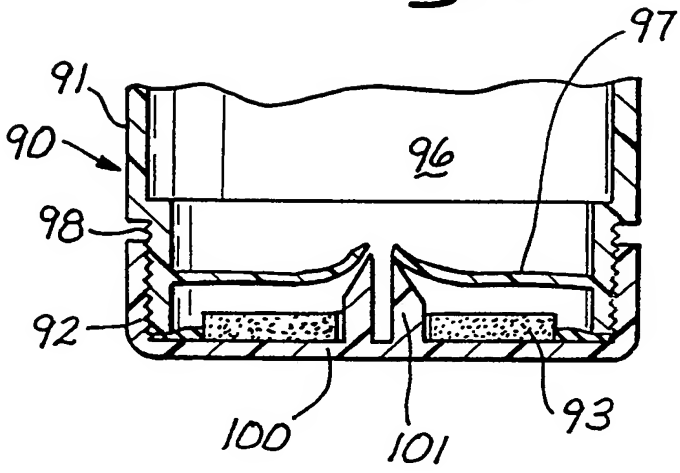


Fig. 11



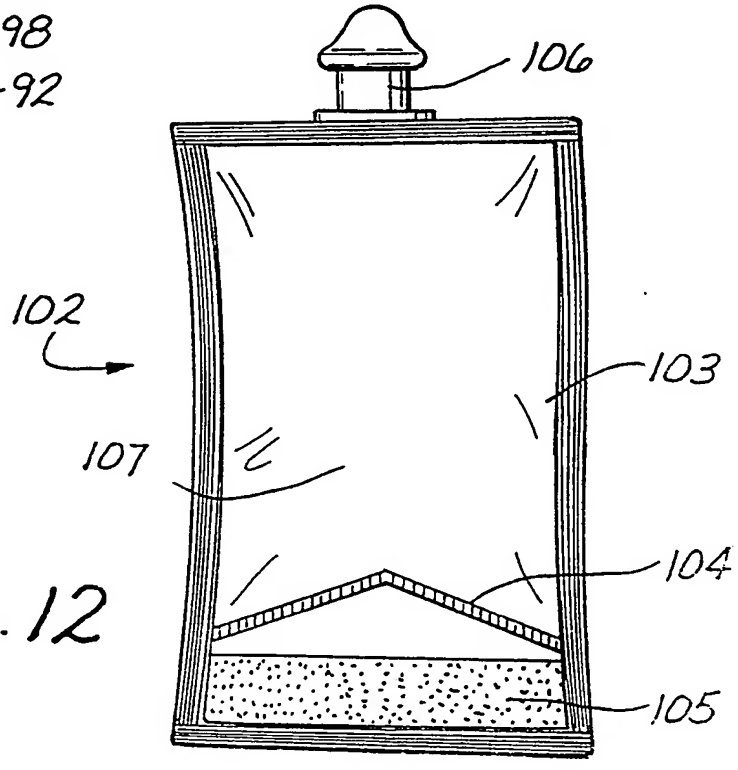


Fig. 12

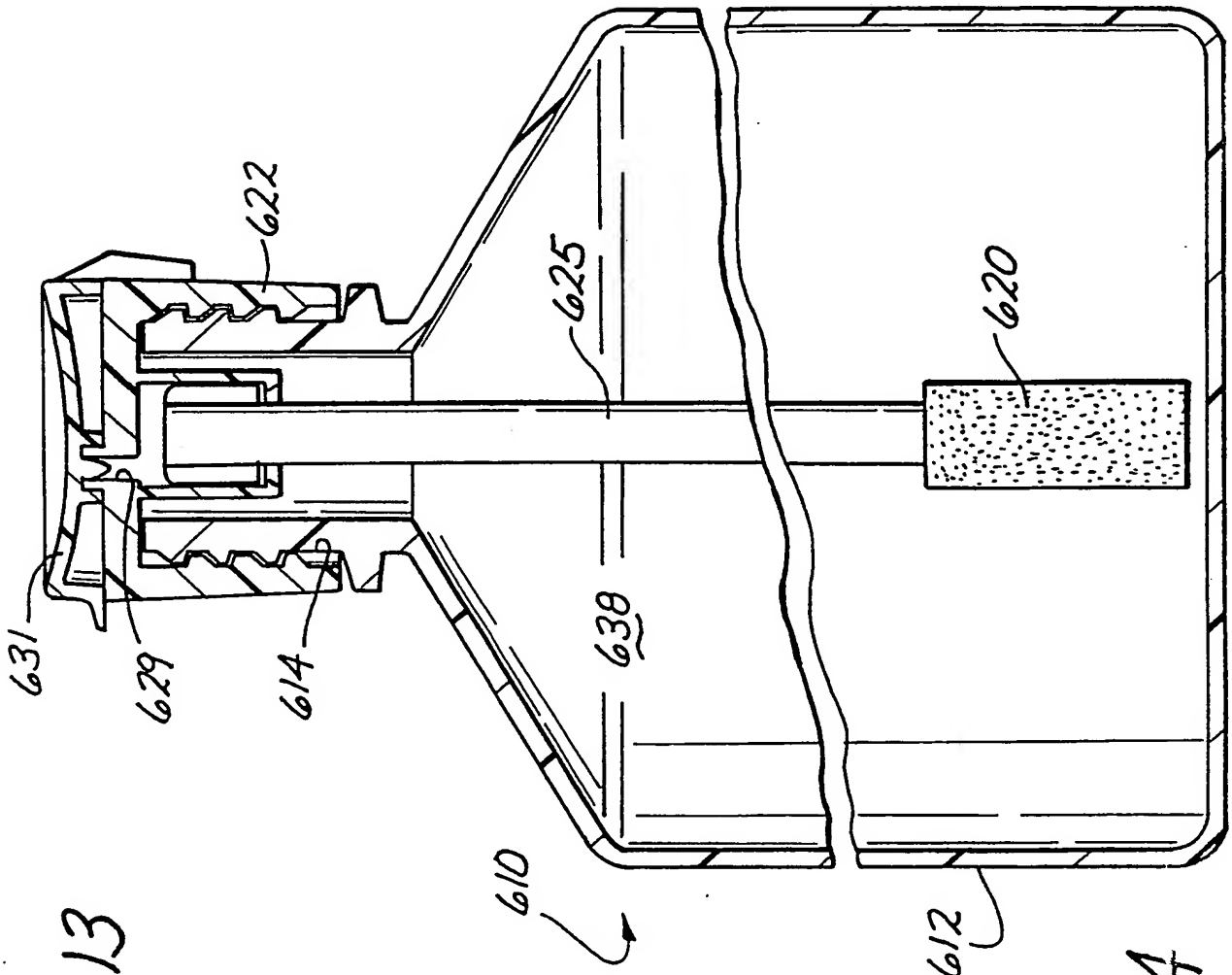


Fig. 13

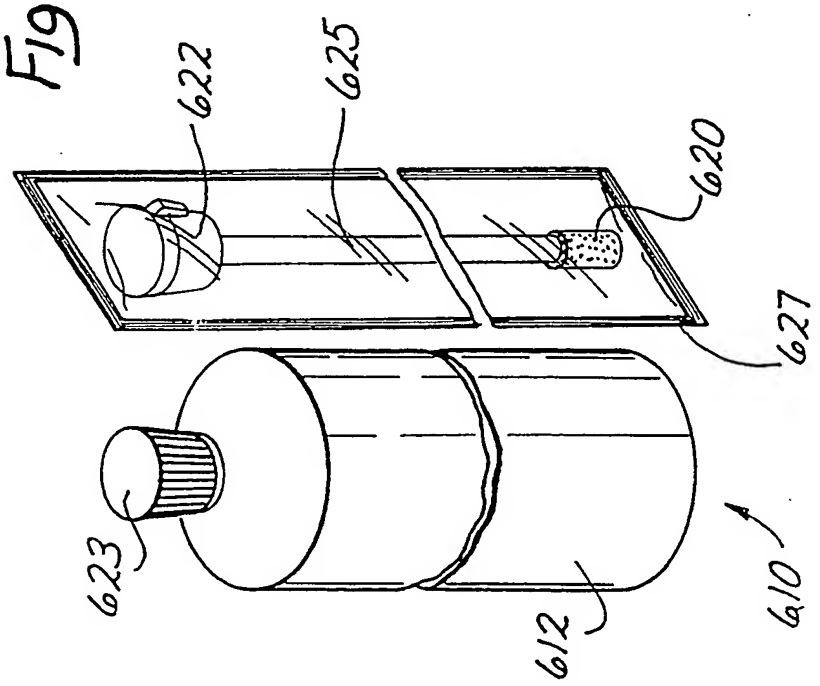


Fig. 14

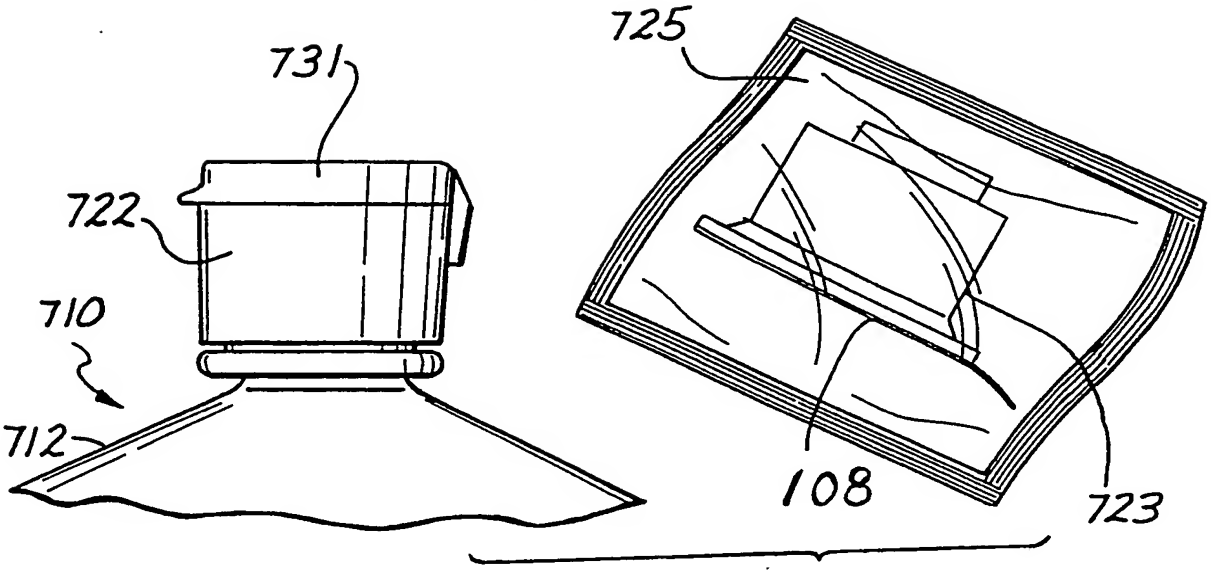


Fig. 15

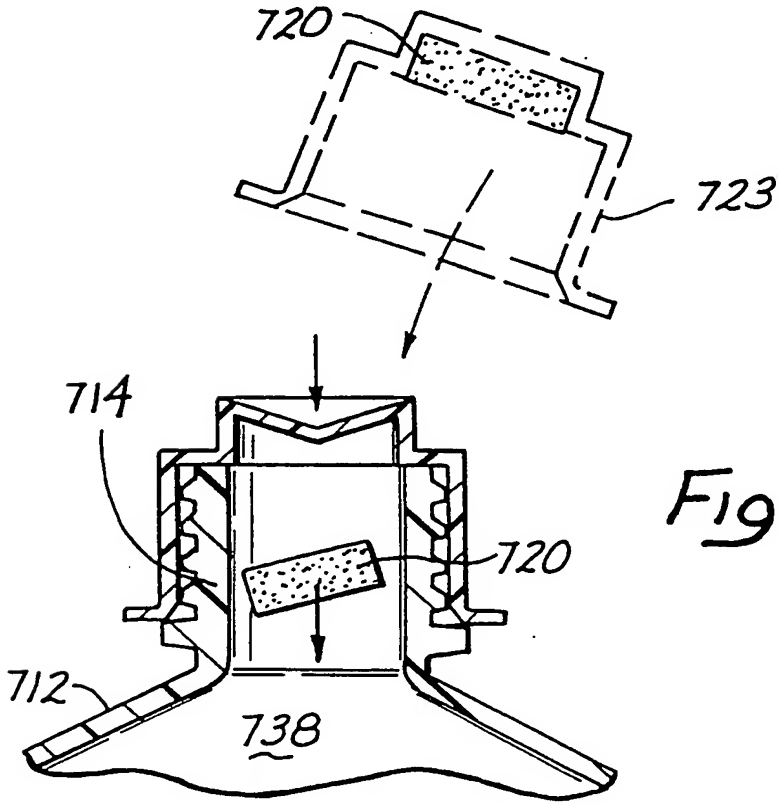


Fig. 16

INTERNATIONAL SEARCH REPORT

International Application No PCT/US 93/00841

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl. 5 B65D51/28; B65D81/32

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
Int.Cl. 5	B65D

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched[8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category °	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No.[13]
X A	EP,A,0 077 556 (BARAM) 27 April 1983 see page 6, line 31 - page 7, line 25; figure 1	1-3,5,6 29,30
X	US,A,4 315 570 (SILVER) 16 February 1982 see column 5, line 56 - column 7, line 56; figures 1-4	1-3,7,9
X	US,A,3 924 741 (KACHUR) 9 December 1975 see column 2, line 26 - column 3, line 36; figures 1-5	1-3,10, 11
X	US,A,2 859 898 (MENDENHALL) 11 November 1958 see column 2, line 61 - column 3, line 46; figures 1-5	1-3,12, 13

-/--

° Special categories of cited documents : [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
25 MAY 1993	09. 06. 93
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	VANTOMME M.A.

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category °	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
X	US,A,3 347 410 (SCHWARTZMAN) 17 October 1967 see column 2, line 40 - column 3, line 66; figures 1-6	1-3,15, 16
X	US,A,3 070 093 (SARNOFF) 25 December 1962 see column 12, line 36 - column 13, line 58; figure 10	1-4,17, 19
X	EP,A,0 345 774 (YOSHIDA) 13 December 1989 see page 4, line 14 - line 58; figures 1,2	1-3,20, 21
X	US,A,3 139 121 (BALLIN) 30 June 1964 see column 2, line 68 - column 3, line 67; figures 1-4	1-3, 22-24
X	FR,A,1 591 549 (RICHARDSON-MERREL) 5 June 1970 see page 2, line 2 - line 37; figures 1-5	1-3, 25-28

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. US 9300841 SA 70382

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP-A-0077556	27-04-83	US-A- 4513861	30-04-85
US-A-4315570	16-02-82	None	
US-A-3924741	09-12-75	None	
US-A-2859898		None	
US-A-3347410		None	
US-A-3070093		None	
EP-A-0345774	13-12-89	JP-A- 2004671 US-A- 4961495	09-01-90 09-10-90
US-A-3139121		None	
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